Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Project No. 1158-5
Report No. 5
June 11, 1963

X-RAY DIFFRACTION ANALYSIS OF MICRO QUANTITIES OF CHEMICAL SUBSTANCES

I. STATEMENT OF THE PROBLEM

The objective of this program is to develop an x-ray diffraction procedure capable of identifying small (0.001 milligram) quantities of chemicals.

II. OBJECTIVES FOR REPORTING PERIOD

During this reporting period the objectives of the program were to add more substances to the catalogue of x-ray powder diffraction patterns, to continue to improve techniques, and to prepare decks of Termatrex cards to receive the catalogued data.

III. SUMMARY AND CONCLUSIONS

During this reporting period we have continued to catalogue x-ray powder diffraction patterns. Some 45 substances have now been catalogued (see Table 2). As a check on our work, we obtained the powder diffraction pattern from germanium dioxide (hexagonal). Measurement of this pattern yields apparent atomic spacings which agree with those listed as standard by the National Bureau of Standards (see Table 3). We have received the Termatrex cards and equipment. These include a machine for preparing cards as well

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

as searching a deck of prepared cards and a deck of Termatrex cards for searching the ASTM x-ray powder diffraction data file. The values of apparent atomic spacing into which our data is to be coded have been established (see Table 1), and the decks of Termatrex cards labeled. However, we have not drilled any cards, since we are waiting to try to coordinate our Termatrex numbers for the compounds with those already in use by other contractors.

IV. EXPERIMENTAL PROCEDURE

A. Diffraction Pattern Cataloguing

Our method of producing and measuring x-ray powder diffraction patterns remains essentially unchanged from that outlined in Letter Report No. 4. A minute quantity of powdered sample (one milligram or less) is confined in the hole in a small brass or lead washer. These holes range in size from less than 0.1 mm to 0.5 mm diameter. The sample is irradiated by a narrow beam (0.08 mm diameter) of monochromatic copper x-rays. The diffracted x-rays impinge on a piece of photographic film the size of a postage stamp. The diffraction pattern consists of a series of concentric rings whose diameters depend on the various atomic plane spacings in the sample. The film is measured to determine the angular deviations of the x-rays producing the diffraction rings. From these angles the apparent atomic spacings are determined. Usually a small amount of standard powder (magnesium oxide) is added to the sample. The standard produces a sharp ring of known atomic spacing. The apparent atomic spacings of the sample are then computed in terms of the sharp ring from the standard. Due to the high atomic number of magnesium compared to

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

those of carbon, oxygen, and hydrogen, adding a small amount of MgO to an organic sample increases the x-ray absorption in the sample. The increased absorption results in increased exposure time. We have made tests to determine the possibility of utilizing lithium carbonate as internal standard. Lithium has a lower atomic number than carbon and oxygen and absorbs much less x-rays than magnesium. These preliminary tests indicate that Li_2CO_3 may be useful as a standard.

B. Termatrex System for Filing and Retrieving Data

The Termatrex system utilizes a square array of 10,000 hole positions in a deck of thin plastic cards. The hole positions are assigned to the items to be described, e.g., chemical compounds. Each card represents one particular characteristic that several items have in common, e.g., molecular weight. Hence, the hole positions for all compounds of one molecular weight would be drilled out. Similarly, cards may be drilled for other characteristics such as melting point, color, etc. One deck of cards is required for every 10,000 items to be described. The deck will consist of as many cards as are necessary to break down the data. The operation of the system can best be explained in terms of an actual set of cards, the Termatrex decks for searching the ASTM x-ray powder data. There are about 150 cards divided into three decks. Deck A consists of 50 cards covering the d/n values from 1.5 to 10.0 A.U. The range of d/n values on one card varies from about 0.1 A.U. for the low end to 1.5 A.U. at the upper end. Deck B consists of 47 cards covering the same d/n values, but the ranges in Deck B are displaced about one-half range with respect to Deck A.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Deck C consists of 52 cards covering the chemical elements. Major elements such as aluminum, iron, oxygen, etc., are represented by individual cards. Less frequently occurring elements, such as the rare earths, radioactive elements, noble metals, etc., are grouped together on cards. There are also cards listing the minerals, hydrates, and alloys. Oxygen and hydrogen are punched into colored transparent cards as well as opaque cards.

To use the system, one selects from either Deck A or Deck B the cards which cover the d/n values obtained from the x-ray powder diffraction pattern of an unknown substance. The selected cards are then stacked together on top of an illuminated viewing box. The cards must be in precise register with the viewing box and with each other. Where a hole position is drilled out in all cards on the viewer, light will, of course, come through. If no holes light up, then the card or cards covering the weakest diffracting ring or rings can be removed. If too many holes are lighted, then pairs of cards should be selected from both Decks A and B so that each pair covers a narrower range of d/n values. The viewing box is equipped with a coordinate system for indexing the 10,000 positions. The "y" is read first and the "x" second, both as two digits; e.g., 0000 would be the upper left starting position. Termatrex has been set up so that the y axis is always read first. There is an index supplied with the decks which lists the Termatrex coordinates, substance, and ASTM file number. There are 5700 entries. Thus, the holes in the Termatrex cards suggest ASTM file data which may be the same substance as the unknown. If the chemical elements in the unknown have been identified, then appropriate cards from Deck C may be added to the stack on the viewer.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

It must be kept in mind that the Termatrex cards only supplement the ASTM file cards. One must return to the ASTM file to get any real data on the substances covered by the Termatrex cards.

C. Termatrex System for [redacted] Data 50X1

The Termatrex viewing box purchased on this program is equipped to drill the Termatrex cards as well as search them. The Termatrex people suggested that we utilize the same cards as are used for the ASTM data. Hence, we acquired blank decks A, B, and C, as described above. These decks are very obviously custom marked for the ASTM data. Unfortunately, the data we have accumulated thus far on organic compounds do not fall into the same ranges as are used for filing the ASTM data. Our values tend to be higher than those in the ASTM file (1.5 - 10.0). We have few values less than 2.5 and we have many values between 5 and 6 where the ASTM data "thin out." Thus it was decided that our file should cover the range from 2.5 to 12.0 rather than from 1.5 to 10.0 as for the ASTM data. Table 1 lists the Termatrex card numbers and the corresponding d/n ranges. There are no cards contemplated currently for the chemical elements, since most of our data concern organics.

As an example of the method of drilling the Termatrex cards, consider anthracene, the first entry in Table 2. Note that for anthracene we have obtained one intense ring, and six rings of intensity considerably less than the first ring. The data for the two weakest rings are dropped, leaving five rings. In general, only five or six rings from one pattern are of sufficient intensity to be considered. Indeed, the original ASTM file card sets contain only three cards for each

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

compound. The three strongest d/n values are used to index the three cards. One card is printed for each of the three strongest values. Using the Termatrex cards, we may select as many d/n values for one compound as are really useful. For anthracene, the following cards will all be drilled at the same coordinate: from Deck A of Table 1, green/57, orange/90, green/90, green/15, and black/40; from Deck B of Table 1, green/50, orange/95, green/80, green/10, and black/44. None of the blank Termatrex cards have been drilled yet. We are postponing drilling any cards until we have definite instructions as to the Termatrex coordinates to be utilized. That is, we shall wait until notified whether the Termatrex coordinates for the compounds we have catalogued are to originate with us or from the outside.

V. DATA

Table 2 presents the data obtained from 45 materials thus far in the program. The data in this table are tabulated for each substance in the manner used by the ASTM. The apparent atomic spacings (d/n) are listed in order of decreasing intensity. Whenever the Termatrex cards are drilled, three or more most intense d/n values for each substance will be entered into the Termatrex decks.

In about a dozen cases, the diffraction patterns have been rerun one or more times. In all cases the differences in the data have been very slight.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

VI. ANALYSIS OF DATA

Table 3 compares our data for a particular compound with the data published as standards by the National Bureau of Standards. The NBS data are obtained by a diffractometer and radiation counter from rather large samples. Our data are obtained photographically using very small samples. The compound chosen was germanium dioxide (hexagonal). This compound was selected since it has no state of hydration and crystallizes in only two systems, hexagonal and tetragonal. The tetragonal converts to the more common hexagonal form upon heating. Note that our data agree within 1% with the NBS data except for our 4.27 and 1.99 values. The 4.27 ring is rather small in diameter. The larger d/n values are actually measured less precisely than the small d/n values. For the 1.99 value, the NBS data list a very weak intensity. The general agreement of the two sets of data demonstrates that our "postage stamp" films present valid x-ray powder diffraction patterns.

VII. GOALS FOR NEXT REPORTING PERIOD

A. Cataloguing of new compounds will be continued throughout the period. The backlog of samples submitted by the sponsor has first been augmented. This backlog will provide sufficient material for cataloguing during the next period.

B. The Termatrex cards will be drilled during the next period, provided that we are supplied with Termatrex coordinates for the compounds of interest to the sponsor or given instructions to assign coordinates at our

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

discretion. There is no pressing need that the question of Termatrex coordinates assignment be decided soon, as drilling the cards will require very little time.

C. Our technique continues to improve. During the next period, some effort will be made to remove or extract samples from the substrate. Currently, we cannot predict the degree of success to be expected.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 1. d/n RANGES FOR TERMATREX CARDS CONTAINING [redacted] POWDER DATA

50X1

DECK A

Card No.	d/n Range	Card No.	d/n Range
Yellow/22	Less than 2.500	Green/ 25	4.200 - 4.299
" 53	2.500 - 2.569	" 35	4.300 - 4.399
" 58	2.570 - 2.639	" 45	4.400 - 4.499
" 66	2.640 - 2.709	" 57	4.500 - 4.649
" 72	2.710 - 2.779	" 72	4.650 - 4.799
" 80	2.780 - 2.849	" 90	4.800 - 4.999
" 87	2.850 - 2.919		
" 94	2.920 - 2.999	Purple/10	5.000 - 5.199
		" 32	5.200 - 5.399
Black/ 02	3.000 - 3.059	" 50	5.400 - 5.599
" 10	3.060 - 3.139	" 71	5.600 - 5.799
" 17	3.140 - 3.209	" 92	5.800 - 5.999
" 24	3.210 - 3.279		
" 32	3.280 - 3.359	Yellow/60	6.000 - 6.299
" 40	3.360 - 3.439	Orange/65	6.300 - 6.699
" 48	3.440 - 3.519	Sand/ 68	6.700 - 6.999
" 56	3.520 - 3.599	Orange/70	7.000 - 7.399
" 64	3.600 - 3.679	" 76	7.400 - 7.899
" 72	3.680 - 3.759	" 80	7.900 - 8.499
" 80	3.760 - 3.839	" 90	8.500 - 9.499
" 88	3.840 - 3.919	" 99	9.500 -10.499
" 96	3.920 - 3.999		
Green/ 05	4.000 - 4.099	Sand/ 10	10.500 -11.999
" 15	4.100 - 4.199	White/ 20	12.0 & Greater

DECK B

Card No.	d/n Range	Card No.	d/n Range
Yellow/51	2.460 - 2.529	Green/10	4.050 - 4.149
" 54	2.530 - 2.599	" 20	4.150 - 4.249
" 62	2.600 - 2.669	" 30	4.250 - 4.349
" 69	2.670 - 2.739	" 40	4.350 - 4.449
" 75	2.740 - 2.809	" 50	4.450 - 4.569
" 85	2.810 - 2.879	" 65	4.570 - 4.719
" 92	2.880 - 2.949	" 80	4.720 - 4.899
" 99	2.950 - 3.019	" 99	4.900 - 5.099

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 1. d/n RANGES FOR TERMATREX CARDS
CONTAINING [redacted] POWDER DATA (Cont'd)

50X1

DECK B (Cont'd)

Card No.	d/n Range
Black/ 06	3.020 - 3.099
" 14	3.100 - 3.169
" 21	3.170 - 3.239
" 28	3.240 - 3.319
" 36	3.320 - 3.399
" 44	3.400 - 3.479
" 52	3.480 - 3.559
" 60	3.560 - 3.639
" 68	3.640 - 3.719
" 76	3.720 - 3.799
" 84	3.800 - 3.879
" 92	3.880 - 3.959
" 99	3.960 - 4.049

Card No.	d/n Range
Purple/18	5.100 - 5.299
" 39	5.300 - 5.499
" 57	5.500 - 5.699
" 81	5.700 - 5.899
Purple/60	5.900 - 6.149
" 64	6.150 - 6.499
" 67	6.500 - 6.849
" 69	6.850 - 7.199
Orange/75	7.200 - 7.599
" 78	7.600 - 8.199
" 85	8.200 - 8.999
" 95	9.000 - 9.999
Sand/ 05	10.000 -11.199

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 2. TABULATION OF APPARENT ATOMIC PLANE SPACINGS AND INTENSITY RATIOS FOR THE DIFFRACTION RINGS FROM SEVERAL POWDERED SAMPLES

The upper row of figures in each case is apparent spacing (d/n). The lower row of figures is the intensity ratio, I/I_o, taking the most intense ring as I_o.

Anthracene	4.54	9.08	4.83	4.14	3.43	3.53	3.02
	1.00	0.42	0.35	0.32	0.29	0.20	0.19
Ethyl Cellulose	10.50	7.95	4.41				
	1.00	0.98	0.79				
Hemin	8.98	5.32	4.23	3.71			
	1.00	0.92	0.82	0.75			
Na_2EDTA Ca	10.33	8.19	17.90	5.77	5.12		
	1.00	0.88	0.87	0.77	0.75		
Carbanthrene Violet	12.23	7.97	3.86				
	1.00	0.99	0.60				
Na_2EDTA Zn	6.33	8.98	5.00	12.51	4.30	3.69	3.24
	1.00	0.95	0.90	0.88	0.80	0.75	0.70
Na_2EDTA	4.98	3.44	3.10	4.27	7.91		
	1.00	0.96	0.93	0.92	0.83		
Na_2EDTA Mg	6.28	5.16	4.38	11.56	3.74	3.52	
	1.00	0.69	0.62	0.60	0.60	0.60	
MgO	4.64	2.10	6.51	2.43	2.32		
	1.00	0.83	0.82	0.45	0.34		
8-Hydroxyquinoline	6.16	3.75	3.46	3.17	9.62	4.55	
	1.00	0.89	0.84	0.81	0.81	--	
Na_4EDTA	12.30	7.44	5.53	3.70	4.76	3.28	
	1.00	0.61	0.59	0.53	0.51	0.39	
Isopropyl Jade Green	13.88	8.65	4.48	5.94	3.51	3.04	2.53
	1.00	0.99	0.92	0.91	0.87	0.66	--

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 2. TABULATION OF APPARENT ATOMIC PLANE SPACINGS AND INTENSITY RATIOS FOR THE DIFFRACTION RINGS FROM SEVERAL POWDERED SAMPLES (Cont'd)

Paper	3.76	4.02	5.49	3.01	2.48	2.26	6.88
(Beverly Bond)	1.00	0.94	0.80	0.49	0.49	0.45	--
Whatman No. 2	3.78	4.17	5.50	2.53	3.07	2.27	2.11
Filter Paper	1.00	0.76	0.76	0.45	0.40	--	--
Sulfite Paper	3.87	4.24	5.38	6.61	2.51	2.25	
	1.00	0.85	0.85	0.64	0.50	0.28	
Dialysis Tubing	4.19	8.56	3.09	2.52	2.18		
	1.00	0.85	0.48	0.32	0.23		
216 F-1	4.65	14.59	5.73	3.95	7.05	3.29	
	1.00	0.88	0.65	0.65	0.43	0.35	
Sudan III CI 248	6.55	3.34	12.88	4.85	7.46	3.54	4.33
	1.00	0.78	0.69	0.62	0.61	0.60	0.57
	5.62	4.03	10.97	3.10			
	0.56	0.56	0.52	0.48			
Mylar	8.41	5.34	3.49	2.68			
	1.00	0.63	0.29	0.21			
Uric Acid	3.08	3.17	3.86	2.47	2.53	5.62	6.56
	1.00	0.83	0.68	0.66	0.53	0.43	0.40
	4.89	5.21	1.85	4.47	2.86	2.61	2.28
	0.40	0.34	0.34	0.30	0.28	0.28	0.28
	2.23	2.80	1.94	2.72	2.05	3.38	10.46
	0.28	0.23	0.23	0.21	0.21	0.17	0.13
No. 6	5.32	6.78	4.27	4.09	11.60	3.79	3.36
	1.00	0.96	0.95	0.86	0.77	0.55	--
No. 7	5.57	3.68	7.37	4.42	11.10	2.98	2.87
	1.00	0.81	0.74	0.66	0.55	0.30	0.27
No. 8	3.04	4.21	3.38	4.94	3.89	7.80	6.16
	1.00	0.96	0.96	0.92	0.90	0.88	--
No. 9	9.98	6.80	4.43	6.26	3.86	3.57	3.14
	1.00	0.99	0.97	0.85	0.80	0.50	0.49

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 2. TABULATION S OF APPARENT ATOMIC PLANE SPACINGS AND INTENSITY RATIOS FOR THE DIFFRACTION RINGS FROM SEVERAL POWDERED SAMPLES (Cont'd)

No. 10	4.34	6.70	3.68	5.65	3.07	2.78	2.63
	1.00	0.98	0.92	0.83	0.74	--	--
No. 11	8.09	5.40	3.96	4.32	4.63	6.68	3.75
	1.00	0.96	0.92	0.91	0.90	0.77	--
No. 12	8.25	5.65					
	1.00	0.90					
No. 13	9.10	4.86	2.77	2.59			
	1.00	0.92	0.80	0.72			
No. 14	8.72	5.61					
	1.00	0.90					
No. 15	8.66	5.34					
	1.00	0.79					
Dimethylglyoxime	5.77	5.06	3.59	3.29	3.43	2.56	6.34
	1.00	0.97	0.70	0.55	0.49	0.34	0.27
	2.91	10.93	2.33	2.42	2.14		
	0.18	0.15	0.14	0.13	0.10		
Pyrazalone	4.11	4.51	3.49	3.61	3.35	7.72	3.17
	1.00	0.72	0.55	0.48	0.37	0.36	0.30
	6.52	4.83	6.95	9.06	5.97	5.22	
	0.27	0.27	0.21	0.18	0.15	0.15	
	5.53	2.63					
	0.12	--					
Paraffin	4.09	3.66	16.34	11.42	7.92	2.94	2.47
	1.00	0.97	0.78	0.63	0.63	0.22	0.19
Diacetyl Benzidine	4.74	7.39	4.45	3.73	4.00	6.24	10.19
	1.00	0.87	0.55	0.45	0.40	0.35	0.30
	5.68	3.33	2.71				
	0.25	0.20	--				
Aspirin	5.58	3.89	11.21	3.29	4.20	2.85	2.53
	1.00	0.72	0.69	0.68	0.67	--	--

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 2. TABULATION OF APPARENT ATOMIC PLANE SPACINGS AND INTENSITY RATIOS FOR THE DIFFRACTION RINGS FROM SEVERAL POWDERED SAMPLES (Cont'd)

Sulfaguanidine	6.23	4.33	4.05	5.28	3.63	3.05	11.87
	1.00	0.94	0.74	0.58	0.49	0.38	0.27
	2.84	2.60	2.47				
	0.15	0.12	0.11				
2-Naphthoic Acid	5.60	3.26	3.43	15.46	5.08	3.60	4.79
	1.00	0.52	0.35	0.30	0.22	0.20	0.17
	3.90	4.52	4.24	3.08	7.81	2.27	
	0.16	0.10	0.09	0.03	--	--	
Lead Foil	2.84	2.47					
	1.00	0.60					
Diformylbenzidine	4.46	3.49	1.85	3.93	2.79	1.94	2.98
	1.00	0.74	0.40	0.34	0.32	0.27	0.18
	8.13	13.07					
	0.13	0.06					
Diphenylthiourea	4.47	3.91	12.45	5.41	8.03	3.14	3.67
	1.00	0.45	0.43	0.35	0.30	0.22	0.14
	2.89	3.38					
	0.11	0.10					
Aminopyrine	9.68	6.65	4.30	5.30	3.76	7.80	6.08
	1.00	0.96	0.86	0.66	0.57	0.43	0.36
	3.46	3.08	3.20	2.83			
	0.29	0.23	0.20	0.11			
Sulfanilamide	3.90	4.85	3.11	3.27	6.17	4.10	3.42
	1.00	0.83	0.78	0.65	0.57	0.56	0.52
	8.41	3.66	4.27	6.65	1.85	2.50	
	0.46	0.44	0.43	0.39	0.37	0.33	
	1.94	2.75	2.93	5.29	2.81	2.65	2.24
	0.28	0.22	0.20	0.19	0.17	0.15	0.11
Citric Acid	5.08	3.56	6.40	4.70	3.91	5.58	2.98
	1.00	0.66	0.62	0.59	0.48	0.39	0.35
	2.57	4.25	3.23	2.79			
	0.30	0.25	0.24	0.20			

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 2. TABULATION OF APPARENT ATOMIC PLANE SPACINGS AND INTENSITY RATIOS FOR THE DIFFRACTION RINGS FROM SEVERAL POWDERED SAMPLES (Cont'd)

β-Naphthol	4.50	3.99	3.53	7.63	3.31	3.15	15.16
	1.00	0.91	0.73	0.72	0.67	0.30	0.20
	2.91	5.79	5.04	2.44	2.79	2.69	
	0.19	0.18	0.17	0.15	0.10	0.09	
	2.30						
	0.05						
Octylthiourea	17.58	3.40	4.18	3.69	9.50	7.37	4.60
	1.00	0.86	0.79	0.64	0.52	0.43	0.41
	1.86	1.94	5.98				
	0.22	0.19	0.16				

Note: The dash (--) indicates intensity too weak to measure reliably.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

TABLE 3. COMPARISON OF [redacted] POWDER DIFFRACTION DATA FOR GeO_2 (HEXAGONAL) WITH NBS DATA

50X1

[redacted] Data		NBS Data*	
d/n	I/I_o	d/n	I/I_o
10.83	97		
6.82	44		
4.27	72	4.32	21
4.00	10		
3.78	28		
3.41	100	3.429	100
3.00	24		
2.73	56		
2.48	17	2.496	11
2.36	30	2.366	22
2.27	16	2.283	13
2.16	26	2.159	18
1.99	15	2.018	02
1.94	22		
1.88	34	1.884	08
		1.870	14

50X1

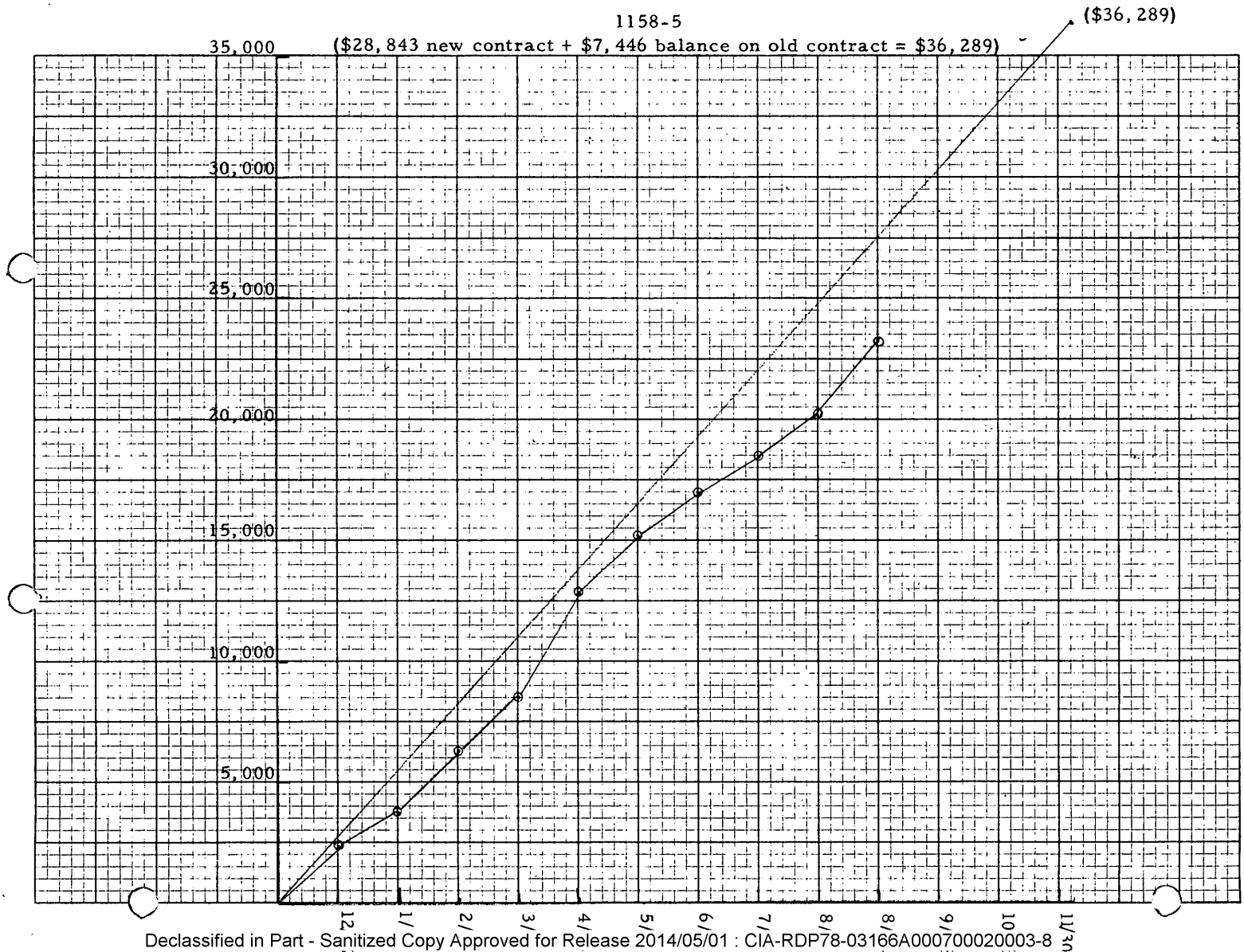
*H. E. Swanson and E. Tatge, Standard X-Ray Diffraction Powder Patterns, N.B.S. Circular 539, Vol. I, 1953, p. 51.

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8

1158-5

($28,843 new contract + $7,446 balance on old contract = $36,289)



Declassified in Part - Sanitized Copy Approved for Release 2014/05/01 : CIA-RDP78-03166A000700020003-8